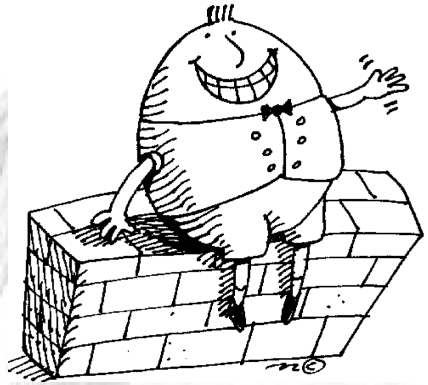
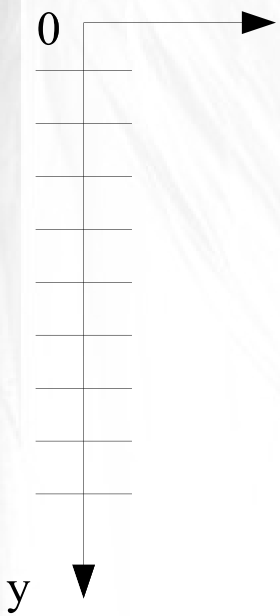


Free-Fall

Kinematics equation in 1 D along vertical

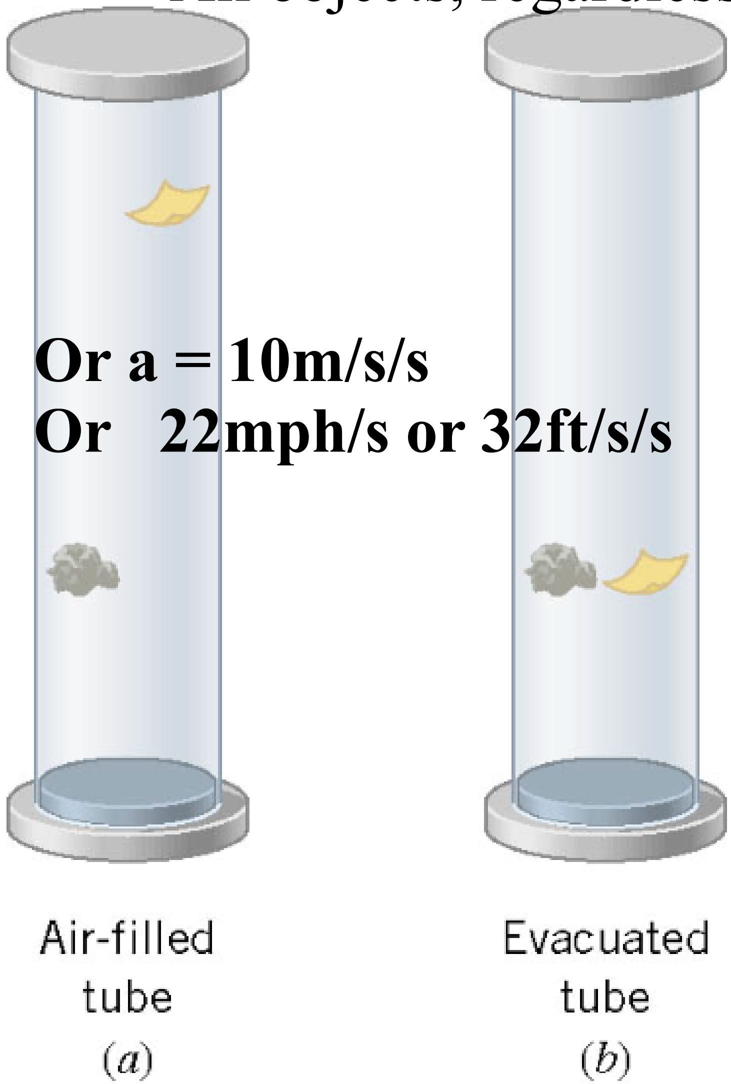


Reference: The physics of everyday phenomena: a conceptual introduction to physics
by W. Thomas Griffith, McGraw-Hill

Conceptual Physics – Paul Hewitt

Free-Fall = no air resistance

All objects, regardless of their masses, have the same acceleration



Or a = 10m/s/s
Or 22mph/s or 32ft/s/s

a=g=-10m/s/s (more precisely -9.8m/s/s)
We are going to use the kinematics equations with
a=-10m/s/s =constant. For an object in free-fall.
The object is acted upon by only the weight.
Weight is pulling down, this is why acceleration is@ down.
We neglect air resistance.

Do demo vacuum tube with penny
And feather. +book and paper +

Galileo Galilei dropping masses from the tower of Pisa is a myth.
He used inclined planes like we did for our labs !

Click on applets below. For the second app:
What kind of relationship there is between the total distance covered
And the time?

Experiment Galileo:

http://dev.physicslab.org/Document.aspx?doctype=2&filename=Kinematics_GalileoRamps.xml

http://www.science20.com/physics_and_computing/galileo_and_relativity_more_about_inclined_planes_and_fun_simulations-75906

How to use the equations of kinematics free-fall:
a=-10m/s/s and Yo=0
Y is the vertical position in on the Y axis (y-coordinate)

$$Y = Vot - 0.5(10)\, t^2$$
$$\text{Or } Y = Vot - 5\, t^2$$

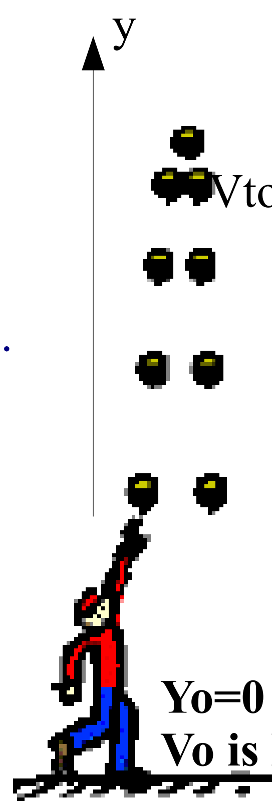
$$V = Vo - 10t$$

$$V^2 = Vo^2 + 2(-10)(Y)$$

For now are are going to work with 2 cases.

See how the Y axis defines the
sign of the position Y.
In both cases Yo=0
But the initial velocity is Vo 0 in one case
And not 0 in another case.

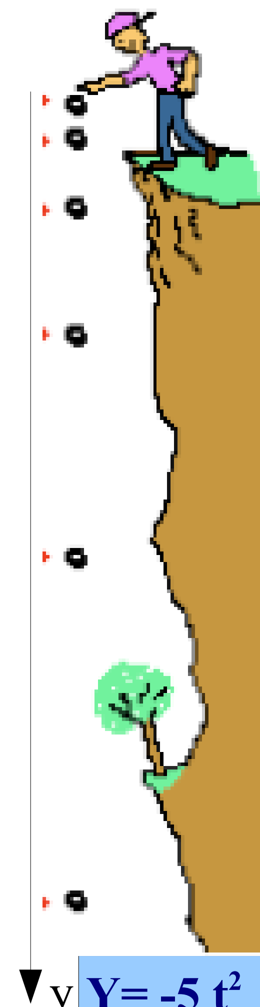
Source images:
Paul Hewitt
Conceptual Physics



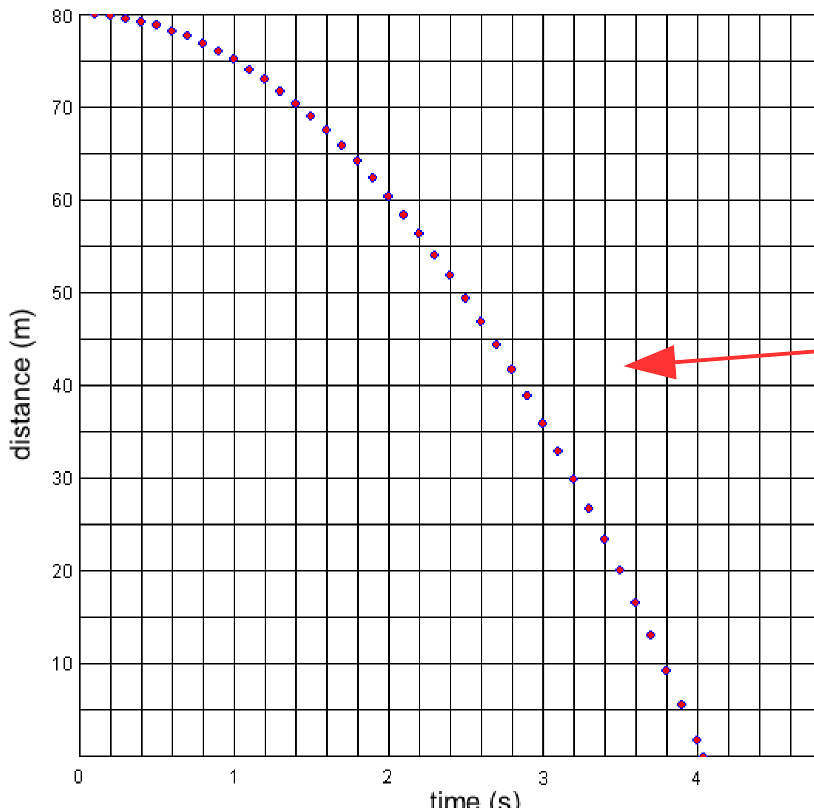
Yo=0 Y> 0
Vo is NOT 0

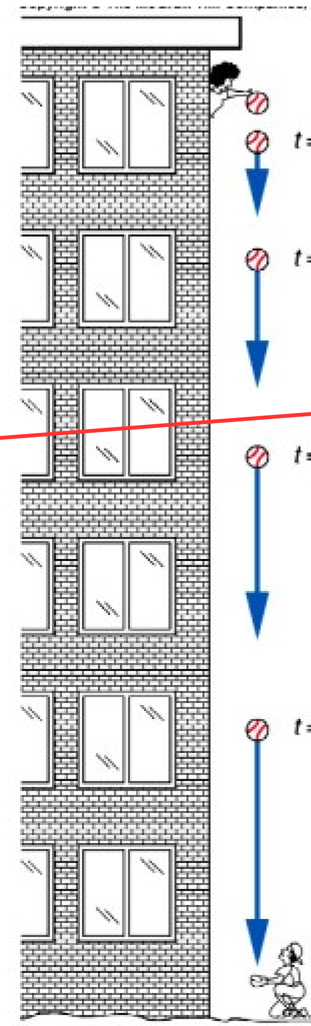
$$Y = Vot - 5\, t^2$$
$$V = Vo - 10t$$
$$V^2 = Vo^2 + 2(-10)(Y)$$
Vtop=0

Yo=0 Y< 0
Vo is 0



$$Y = -5\, t^2$$
$$V = -10t$$
$$V^2 = 2(-10)(Y)$$
Vo=0





See exploration of physical science
Applet # 3

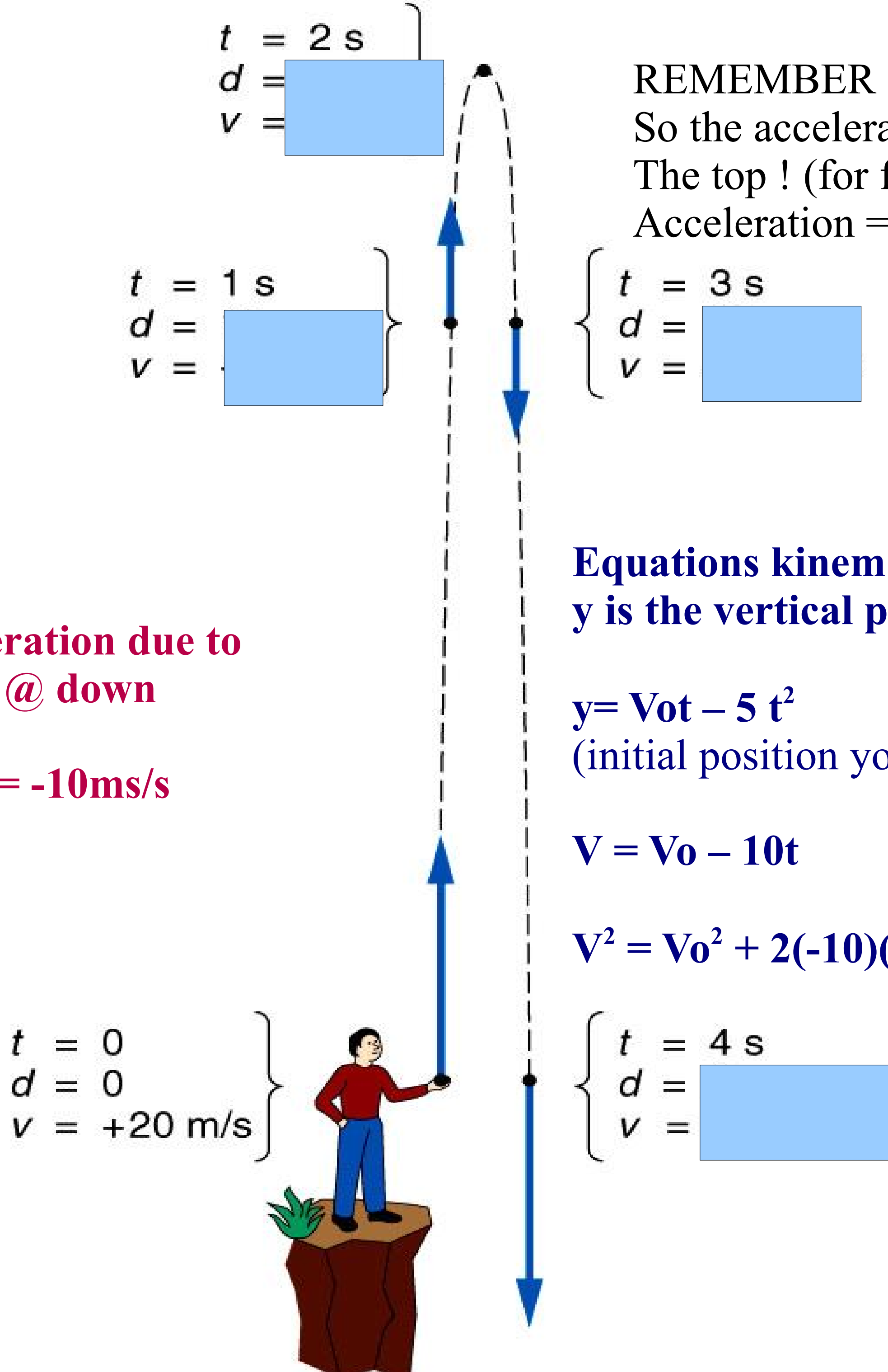
Applet # 3 observe the graph.
The slope is negative or positive ?
Is the speed increases or decreases ?
(think steepness)

Now add air resistance.
What is happening to the graph after
A few second ?? The objects reaches
Terminal speed.

t	0
V	0
y	0

Complete the table. Kinematics equations:
Use Vo=0 and V = -10t
Y=-5 t^2 with a= -10 and Vo=0 and yo=0

REMEMBER : the weight never stops pulling
So the acceleration is always -10m/s/s even at
The top ! (for falling body)
Acceleration = weight per unit mass



The acceleration due to Gravity is @ down

Suppose g= -10ms/s

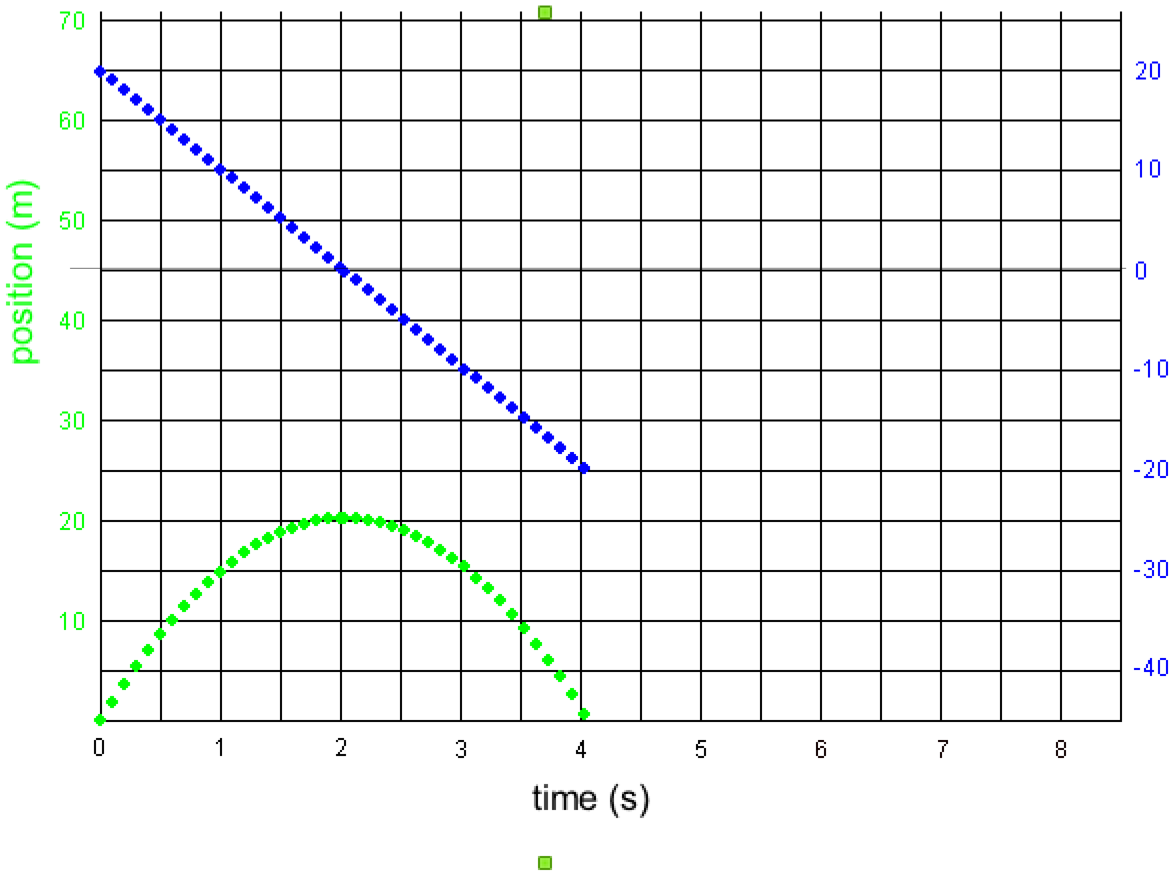
Equations kinematics with a=-10m/s/s
y is the vertical position. Here Vo=20m/s

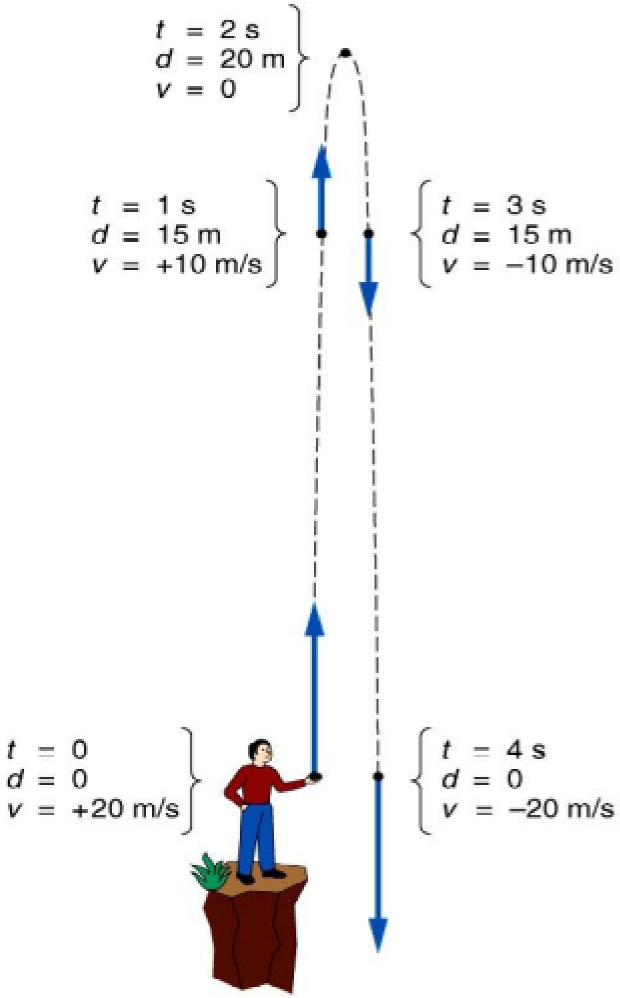
$y = V_o t - 5 t^2$
(initial position yo=0 and d=y here)

$V = V_o - 10t$

$V^2 = V_o^2 + 2(-10)(y)$

Applet 5





Time it takes to go up = time it takes to do down

Time of flight = 2 x time it takes to go up

Example A Falling Stone

A stone is dropped from the top of a tall building. After 3.00s of free fall, what is the displacement *y* of the stone?

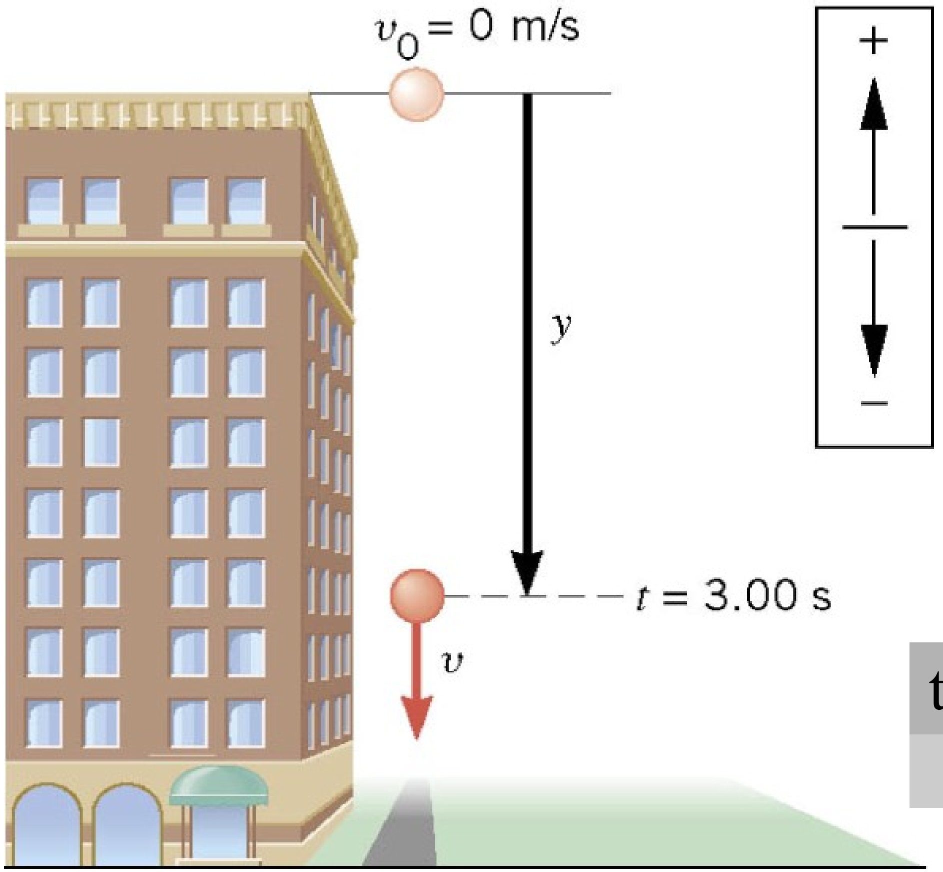
Suppose acceleration a = -10ms/s

1. 45m

2 – 45m

3.-30m

4. 30m



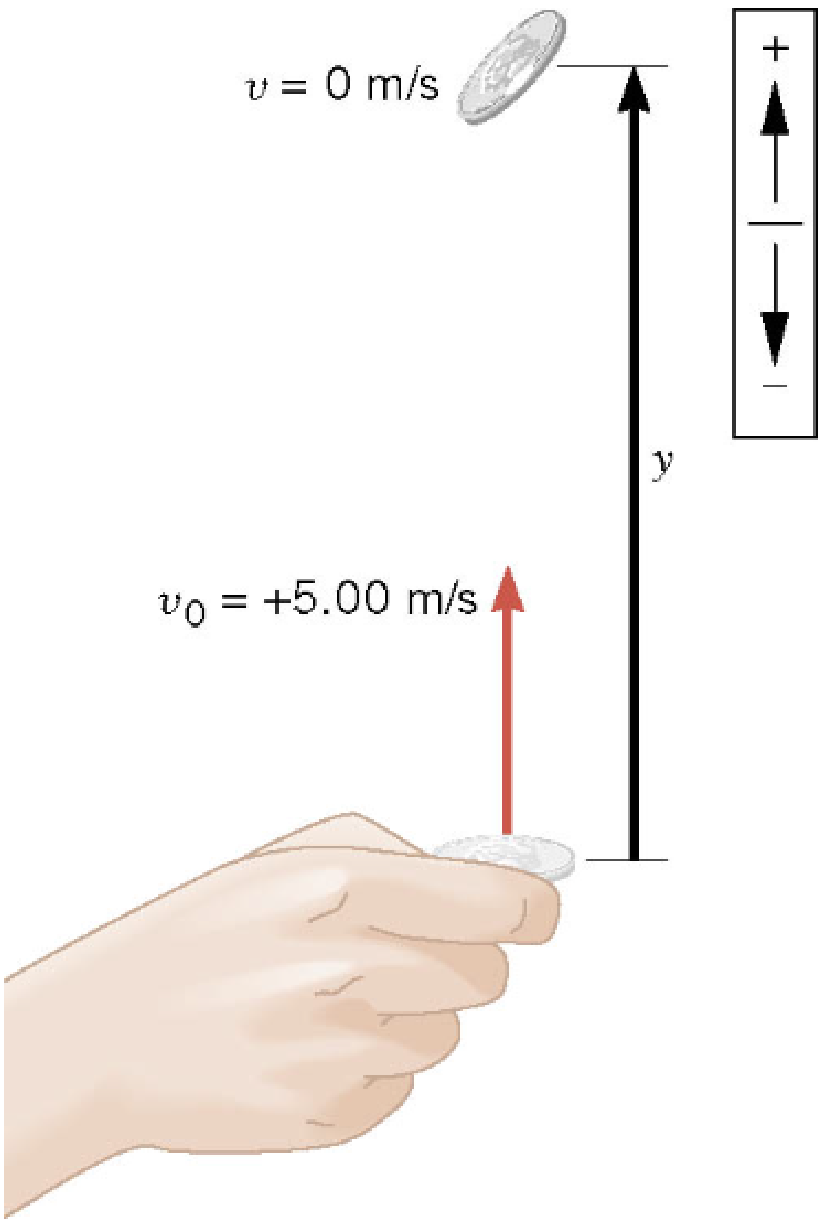
t	a	Vo	V	y
	-10	0		

Example How High Does it Go?

The referee tosses the coin up with an initial speed of 5.00m/s. In the absence if air resistance, how high does the coin go above its point of release?

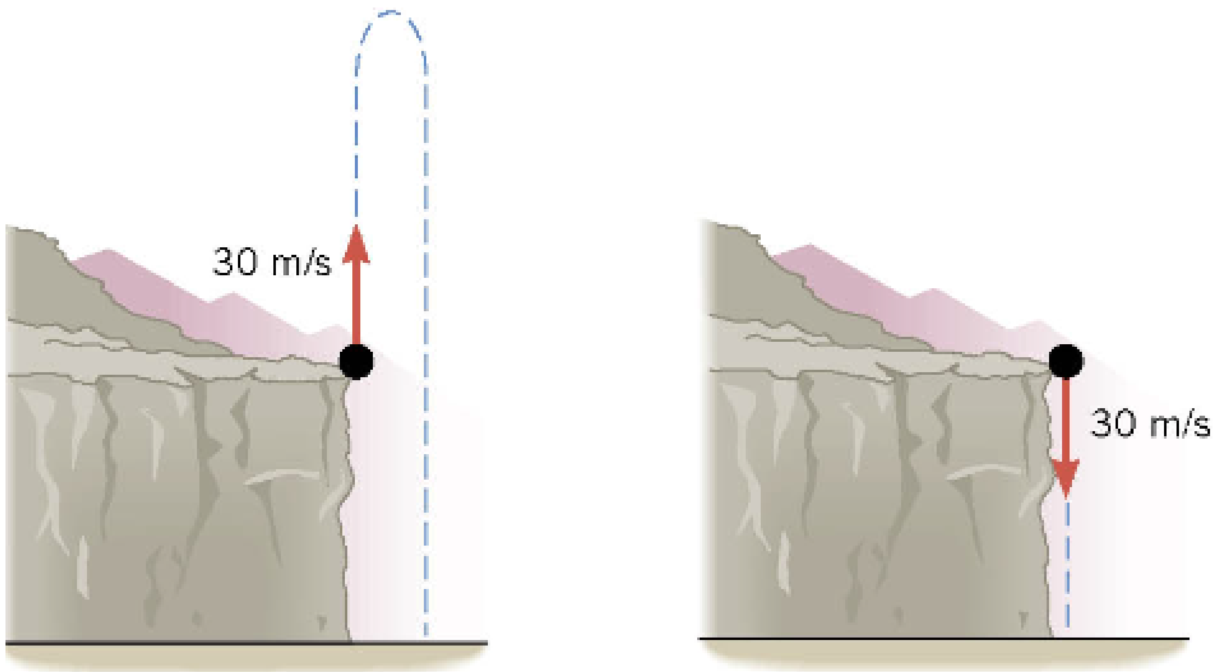
Hint: final velocity (at top of trajectory is 0).

t	a	Vo	V	y
	-10			

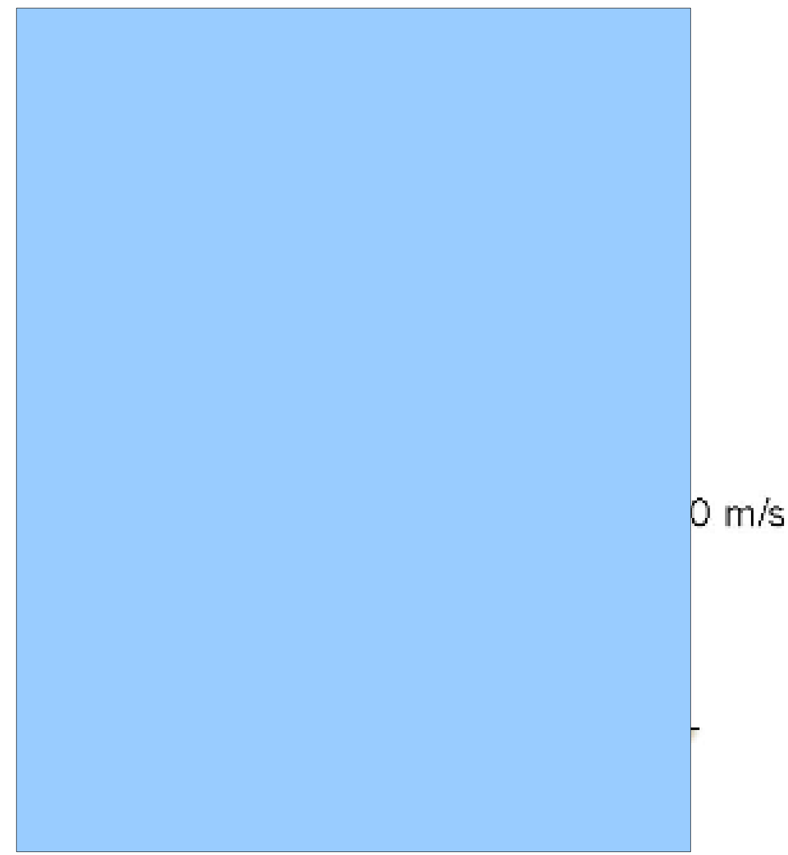


Conceptual Example Taking Advantage of Symmetry

Does the pellet in part *b* strike the ground beneath the cliff with a smaller, greater, or the same speed as the pellet in part *a*?



(*a*) (*b*)



A rock is released from rest from a hot air balloon that is at rest with respect to the ground a few meters below. If we ignore air resistance as the rock falls, which one of the following statements is true?

a) The rock will take longer than one second to reach the ground.

b) The instantaneous speed of the rock just before it reaches the ground will be 9.8 m/s.

c) The rock is considered a freely falling body after it is released.

d) As the rock falls, its acceleration is 9.8 m/s^2, directed upward.

e) After the ball is released it falls at a constant speed of 9.8 m/s.

A ball is thrown vertically upward from the surface of the earth. The ball rises to some maximum height and falls back toward the surface of the earth. Which one of the following statements concerning this situation is true if air resistance is neglected?

a) As the ball rises, its acceleration vector points upward.

b) The ball is a freely falling body for the duration of its flight.

c) The acceleration of the ball is zero when the ball is at its highest point.

d) The speed of the ball is negative while the ball falls back toward the earth.

e) The velocity and acceleration of the ball always point in the same direction.

Watch video Hammer vs father

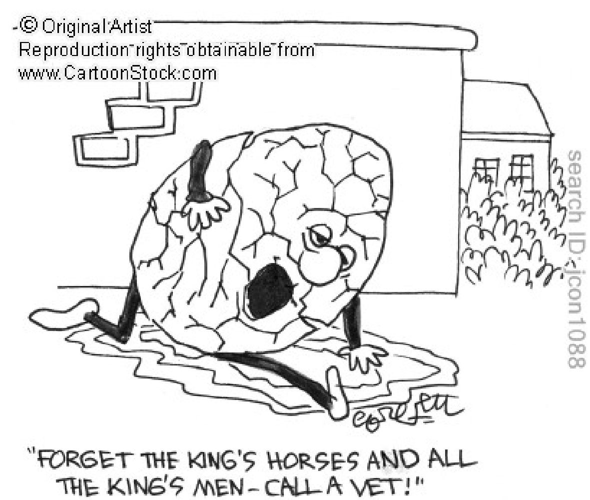
1) a high wire artist missteps and falls 9.2m to the ground. What is her speed on landing ?
Convert to mph.

2) A cat falls out of a tree, dropping 16m to the ground. How long is the cat in the air ?

3) You drop a rock from a bridge, and it hits the water 2.3 s later. Find:
A) the height of the bridge
B) the velocity of the rock when it hits.

4) A steel ball is dropped from a diving platform (with an initial velocity of zero). Using g = -10m/s
A) what is the velocity of the ball 0.8s after its release
B) What is its velocity after 1.6s after its release?
C) through what distance does the ball fall in the first 0.8s seconds of its flight ?
D) How far does it fall in the first 1.6s of its flight ?

5) and bowling ball and a tennis ball are released from rest at the same
Time from a height of 50m.
A) Which one will reach the ground first
B) How long it will take ?



6) A ball is thrown downward with an initial velocity of 12m/s (initial = -12) Using g = -10m/s/s, what is the velocity of the ball 1second After it is released ?

7) A ball is dropped from a high building. Using the approximation g= -10m/s/s, find the **change** in velocity between the first and the fourth Second of its flight.

8) A ball is thrown upward with an initial velocity of 15m/s/s. Using g=-10m/s/s.

What are the magnitude and the direction of the
Ball's velocity. A) 1 second after it is thrown
B) after 2 seconds after it is thrown
C) how high above the ground is the ball after 1 second after it is thrown ?
D) after 2 seconds
E)At what time the ball reach the high point in its flight.

9)Suppose that the gravitational acceleration on a certain planet is only 2m/s/s/
A space explorer standing on this planet thrown a ball Straight up
Straight up ward with an initial velocity of 18m/s.
A) What is the velocity of the ball 4s after it is thrown ?
B) How much time elapses before the ball reached the high point in its flight?
C) How long does it stay in the air/

10) a stone is thrown in the air with initial velocity of 20m/s .
How high does it get ?
Time it takes to reach this max ?
Total time of flight ?